HOME RANGE AND DISPERSAL OF THE AMERICAN MARTEN IN NORTHEASTERN OREGON

EVELYN L. BULL AND THAD W. HEATER

Pacific Northwest Research Station, 1401 Gekeler Lane, La Grande, Oregon 97850 USA

ABSTRACT—Home ranges and dispersal of American martens (*Martes americana*) were determined in northeastern Oregon between 1993 and 1997 to provide managers with information necessary for developing management options to maintain habitat for viable populations. The average home range for males (2717 ha; SD = 1092.9; n = 10) was about twice that of females (1416 ha; SD = 744.3; n = 9). Home ranges were largely mutually exclusive for same-sex martens. Correlation analyses showed no significant linear relationships between the percentage of unharvested forest and home range size. Three juvenile martens (2 males, 1 female) that established home ranges outside the study area dispersed a mean of 33.3 km (range = 28 to 43.2 km).

Key words: American marten, *Martes americana*, dispersal, home range, movements, northeastern Oregon

The American marten (*Martes americana*) occurs predominantly in late seral stages of coniferous forests and is considered one of the most habitat-specialized mammals in North America (Buskirk and Powell 1994; Raphael and Jones 1997). Thus, quality of habitat may exert a strong influence on size of home range and may explain some of the variability in home range size reported in the literature. Powell (1994) summarized results from 19 studies that reported average home ranges of martens: males ranged from 2.0 to 27 km^2 and females ranged from 0.6 to 17 km^2. Buskirk and McDonald (1989) reported home ranges of resident adult martens from 9 study areas and found highly significant differences in home ranges among sites. Some studies described a high degree of fidelity to home range areas (Phillips and others 1998), while others observed martens moving out of their original home ranges (Buskirk 1983; Raphael and Jones 1993; Phillips 1994; Hodgman and others 1997). An intrasexual territorial system in martens has been described by Archibald and Jessup (1984), Balharry (1993), and Katnik and others (1994).

Fewer studies have described juvenile dispersal than adult movements. In Wyoming, 10 kits dispersed 5 to 20 km from their natal ranges, although martens dispersing farther may not have been detected (L. F. Ruggiero, Rocky Mountain Research Station, Missoula, MT; pers. comm.). In Maine, Phillips (1994) reported that 28 juveniles captured from August until November dispersed as early as 27 August, but none continued dispersing through the winter. Weckwerth and Hawley (1962) reported that most of the marten dispersal in Montana was by juvenile males, and that juveniles dispersed to less favorable or unoccupied habitat because they could not compete with resident adults. Archibald and Jessup (1984) reported 2 periods of dispersal in the Yukon; the 1st period occurred between mid-July and mid-September, and the 2nd period was by overwintering martens though the timing was unclear.

Information on home range and dispersal is critical for the development and implementation of management plans designed to provide habitat for viable populations of martens. Because results from 1 geographic area may not apply to other areas (Sturtevant and Bissonette 1997), it is important to obtain data from the target management area. Our objectives were to describe home ranges and dispersal of the American marten in northeastern Oregon. We predicted that martens using areas with a higher percentage of late-successional, unharvested forest would have smaller home ranges.

METHODS

Our study area encompassed about 400 km^2 in the Blue Mountains in northeastern Oregon. A portion of the study area contained 53 km^2

of predominantly unharvested, late-successional forest. The area in a 6-km radius outside this unharvested portion of the study area had been extensively harvested (80% of area logged), fragmented, and roaded since 1960. The landscape was a mosaic of stands in 4 forest types (Johnson and Hall 1990): Douglas-fir (*Pseudotsuga menziesii*), grand fir (*Abies grandis*), lodgepole pine (*Pinus contorta*), and subalpine fir (*A. lasiocarpa*). Study area topography consisted of moderately steep mountains dissected by drainages. Permanent water in the form of springs and streams was abundant. Elevation ranged from 1433 to 1980 m.

Daytime maxima in summer normally exceeded 24°C, and winter low temperatures were typically below freezing with extremes of −15°C being common. Annual precipitation averaged 78 cm with about 60% falling as snow depending on the elevation. At the highest elevation, snow was on the ground from November through April each year with a maximum depth of about 1.5 m. At the lowest elevation, snow was on the ground from December until March, with a maximum depth of about 0.5 m.

We conducted the study from December 1993 to October 1997. Martens were captured in cage live traps with attached plywood boxes for shelter. During December to March and September of each year, we set 40 to 50 traps for 5 days each week in the study area and checked them daily. We did not expect to trap all martens in the study area because some portions were inaccessible.

Captured martens were immobilized with ketamine mixed with xylazine (Bull and others 1996), aged, and fitted with a radiocollar (Holohil Inc., Carp, ON). Age was estimated by analysis of cementum annuli on all martens recovered after death (Poole and others 1994). For individuals without a known age, juveniles and adults were distinguished based on degree of tooth wear at capture (Strickland and others 1982). Radiocollars placed on females weighed 28 g, and those placed on males weighed 35 g; transmitter life was 18 months. Transmitter range varied from 3 to 6 km; the lower range was characteristic of a marten moving on the ground down a drainage, while the upper range was characteristic of a marten in a tree on a ridge.

Radiocollared martens were located visually once per week in the winter and twice per week in the summer. The marten or the specific structure (such as tree, log, or underground site) that the individual was using was located. If the marten was moving, we followed it until we thought we were within 100 m of the animal, and used that point in the home range analysis. Based on sightings of traveling martens, we determined we were within 100 m of a marten if we could detect the signal 0.020 MHz above the actual transmitter frequency; this was tested on > 20 martens. When radio-tracking an individual marten, we recorded date, time, and location which we plotted on orthophoto quadrants (scale of 1:15,840) and converted to UTM (Universal Transverse Mercator) coordinates.

When radio signals of martens could not be located during routine monitoring, we searched from a fixed-wing aircraft in a 30-km radius of the study area within 2 to 4 wk. If a signal was detected, a ground search for the marten was conducted. The aerial locations were not included in home range determination except for 3 martens with home ranges in unroaded areas. With these 3 martens, aerial locations, which comprised <15% of the total locations, were used during periods when the areas were inaccessible by snowmobile because of deep, powder snow and steep terrain. We determined that aerial locations were within 300 m of the animal by ground checking the aerial location within 4 hr on 6 occasions in the winter when martens were unlikely to be traveling during the day.

Home ranges were delineated with the Calhome program (Kie and others 1996), using default settings for optimal band width and grid size. Home range sizes were calculated for each marten with >50 locations using the 100% minimum convex polygon method (MCP) (Odum and Kuenzler 1955) and the adaptive kernel method (95% ADK; Worton 1989). For martens captured as adults, all locations were used in determining home range, except 1 male that used 2 distinct home ranges. In this case, the 2nd home range was used because the marten remained in this area for the remainder of the study. For martens captured as juveniles, only locations in the home range they eventually established were used in home range analysis. A home range was determined from the date that the juvenile stopped making large movements (>4 km) between consecutive locations (made every 2 to 4 days) and stayed in the same vicin-

ity for >3 months. A juvenile marten that traveled >5 km from the capture site was classified as "dispersing." Dispersal distance was calculated from the trap site to the center of an established home range or to a mortality site. All juveniles, except 1, were captured in the winter, so some may have dispersed from the natal area before capture.

Overlap of home ranges was calculated for all adjacent pairs within and between sexes as the ratio of the union of the home ranges to the total home range. Overlap was calculated only for the time period when adjacent pairs coexisted, and it was averaged for each category (percentage of female ranges overlapped by other females, percentage of female ranges overlapped by males, percentage of male ranges overlapped by other males, and percentage of male ranges overlapped by females).

We calculated the percentage of each home range (MCP) that was unharvested using field reconnaissance, aerial photos, and a GIS (Geographic Information System). Timber management usually consisted of partial harvests; regeneration harvest cuts were less common in the study area. Bivariate correlation was used to determine the relationship between home range size (MCP) of males and females and the percentage of unharvested forest within the home range.

RESULTS

Home Range and Movements of Adults

Of 35 radiocollared martens, home ranges were calculated for 19 with an average of 106 locations (range = 53 to 181). The mean home range size of 10 males was 2717 ha (SD = 1092.9, range = 1237 to 4750; MCP) and 2877 ha (SD = 1069.1, range = 1663 to 4784; 95% ADK), while that of 9 females was 1416 ha (SD = 744.3, range = 393 to 2738; MCP) and 1470 ha (SD = 835.6, range = 264 to 2793; 95% ADK). Correlation analyses showed no significant linear relationships between male ($r = -0.11$, $P = 0.77$) or female ($r = -0.01$, $P = 0.98$) home range size and the percentage of unharvested forest.

In general, home ranges in this population were mutually exclusive for same-sex adults. Home ranges for 2 of 6 adult females overlapped with that of an adjacent female by a mean of 3% (range = 2 to 4%). For 8 adult males with radiocollared neighboring males, home ranges overlapped by a mean of 13% (range = 1 to 53%). During the non-breeding season (September through May), home range overlap was the same for females, but only 5 of the 8 male home ranges overlapped ($\bar{x}$ = 10%; range = 1 to 35%). Female-male overlap averaged 64% (range = 1 to 100%), and male-female overlap averaged 28% (range = 1–57%). Home range overlap estimates could be underestimated because it was unknown if all resident martens were radiocollared.

Site fidelity for our study animals was high. Among adult males, only 1 used 2 distinct home ranges in successive years. The first home range of 4290 ha (MCP) was in predominantly harvested habitat while the second home range of 1237 ha (MCP) was in a predominantly unharvested habitat.

Dispersal of Juveniles

Eighteen juvenile martens (12 males, 6 females) were captured during the winters. Nine of these (5 males, 4 females) initiated dispersal between March and May; 6 (5 males, 1 female) remained in areas they occupied during the winter; 1 male and 1 female died during the winter; and 1 male was missing. Of the 9 martens that dispersed, 3 dispersed ($\bar{x}$ = 33.3 km, range = 28 to 43.2 km) and established home ranges outside the study area; 3 dispersed ($\bar{x}$ = 14.2 km, range = 8.6 to 23.6 km) and were killed; and 3 dispersed ($\bar{x}$ = 8.1, km, range = 6 to 9.6) but returned to establish home ranges in the area where they were captured. The dispersal in the spring ended between June and early August, after which the martens remained in the same area and established home ranges.

Each of 3 juveniles that dispersed (2 of which survived to breed) had been in areas occupied by another adult marten of the same sex before they moved. Two of the 5 juvenile males that did not disperse were killed by other martens in May and July; the remaining 3 survived to establish home ranges. Among radiocollared juveniles, 3 (2 males, 1 female) of the 6 non-dispersers and 3 (2 males, 1 female) of the 9 dispersers were killed before they were 16 months old.

DISCUSSION

Our hypothesis that home range size is determined by the amount of unharvested forest

was not supported by our data. Selection of habitat within the home range is likely more important than the abundance of habitats; all radiocollared martens used unharvested, late-successional stands in greater proportion than their occurrence in the home range (Bull, unpublished data). In addition, our habitat classification scheme may not have captured the variation in habitat characteristics that are important to marten. Intraspecific interactions and predation may also be influential in the use and size of a home range. Males with males in adjacent home ranges may be forced to confine their movements to avoid confrontations and possible mortality, whereas males lacking neighboring males can expand their home range boundaries. Katnik (1992) documented range extensions when martens of the same sex in adjacent ranges died.

The home ranges we observed were larger than most of those reviewed by Powell (1994). These larger home ranges may be a function of a combination of factors including prey availability, intraspecific behavior, predation, habitat characteristics, and density of martens.

It appeared that juveniles (at least 9 months old) dispersed in our study area during the spring, although these juveniles may have already moved a considerable distance from their natal areas. Some juveniles remained in the home ranges of adults during the winter, although it was not known if the adults were their parents. The coexistence of juvenile and adult males appeared to end in the spring when 4 males (2 juveniles and 2 adults) were killed by other males in May, June, and July (Bull and Heater 1995).

The current management practice of allocating 65 ha of late-successional forests for each breeding female marten on national forest land in northeastern Oregon (USDA 1990) was established in the 1980s based on the professional judgements of biologists. Eighteen of 19 studies reported by Powell (1994) had home ranges larger than 65 ha for females; the 1 study with a home range of 0.6 km^2 was based on 1 female (Burnett 1981). These studies, in addition to the findings of this study, suggest that if the management goal is to maintain viable populations, there would be a higher probability of success if larger areas (mean of 27 km^2 per pair) were managed for American martens in northeastern Oregon. Managing for adjoining home ranges would increase the probability of retaining a viable population, so individuals can find new mates when others die. Allocating appropriate patches of habitat within 33 km (mean dispersal distance) would likely ensure dispersal of martens among them, provided there is connectivity between suitable habitats.

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LITERATURE CITED

ARCHIBALD WR, JESSUP RH. 1984. Population dynamics of the pine marten (*Martes americana*) in the Yukon Territory. In: Olsen R, Geddes F, Hastings R, editors. Northern ecology and resource management. Edmonton, AB: University of Alberta Press. p 81–97.

BALHARRY D. 1993. Social organization in martens: an inflexible system? Symposia of the Zoological Society of London 65:321–345.

BULL EL, HEATER TW. 1995. Intraspecific predation on American marten. Northwestern Naturalist 76:132–134.

BULL EL, HEATER TW, CULVER FG. 1996. Live-trapping and immobilizing American martens. Wildlife Society Bulletin 24:555–558.

BURNETT GW. 1981. Movements and habitat use of the American marten in Glacier National Park, Montana [thesis]. Missoula, MT: University of Montana. 130 p.

BUSKIRK SW. 1983. The ecology of marten in south-central Alaska [dissertation]. Fairbanks, AL: University of Alaska. 131 p.

BUSKIRK SW, MCDONALD LL. 1989. Analysis of variability in home-range size of the American marten. Journal of Wildlife Management 53:997–1004.

BUSKIRK SW, POWELL RA. 1994. Habitat ecology of fishers and American martens. In: Buskirk SW, Harestad AS, Raphael MG, Powell RA, editors. Martens, sables, and fishers: biology and conser-

vation. Ithaca, NY: Cornell University Press. p 283–296.

HODGMAN T P, HARRISON DJ, PHILLIPS DM, ELOWE KD. 1997. Survival of American marten in an untrapped forest preserve in Maine. In: Proulx G, Bryant HN, Woodard PM, editors. Martes: taxonomy, ecology, techniques, and management. Edmonton, AB: Provincial Museum of Alberta. p 86–99.

JOHNSON CG, JR, HALL F. 1990. Plant associations of the Blue Mountains. Portland, OR: U.S. Forest Service, R6-Ecol. Area 3. 116 p.

KATNIK DD. 1992. Spatial use, territoriality, and summer-autumn selection of habitat in an intensively harvested population of martens on commercial forestland in Maine [thesis]. Orono, ME: University of Maine. 137 p.

KATNIK DD, HARRISON DJ, HODGMAN TP. 1994. Spatial relations in a harvested population of marten in Maine. Journal of Wildlife Management 58: 600–607.

KIE JG, BALDWIN JA, EVANS CJ. 1996. Calhome: a program for estimating animal home ranges. Wildlife Society Bulletin 24:342–344.

ODUM EP, KUENZLER EJ. 1955. Measurement of territory and home range size in birds. Auk 72:128–137.

PHILLIPS DM. 1994. Social and spatial characteristics, and dispersal of marten in a forest preserve and industrial forest [thesis]. Orono, ME: University of Maine. 95 p.

PHILLIPS DM, HARRISON DJ, PAYER DC. 1998. Seasonal changes in home-range area and fidelity of martens. Journal of Mammalogy 79:180–190.

POOLE, KG, MATSON GM, STRICKLAND MA, MAGOUN AJ, GRAF RA, DIX LM. 1994. Age and sex determination for American martens and fishers. In: Buskirk SW, Harestad AS, Raphael MG, Powell RA, editors. Martens, sables, and fishers: biology and conservation. Ithaca, NY: Cornell University Press. p 204–223.

POWELL RA. 1994. Structure and spacing of *Martes* populations. In: Buskirk SW, Harestad AS, Raphael MG, Powell RA, editors. Martens, sables, and fishers: biology and conservation. Ithaca, NY: Cornell University Press. p 101–121.

*RAPHAEL MG, JONES LLC. 1993. Ecology and management of American martens in fragmented habitats of the Pacific Northwest. Progress Report. Olympia, WA: Pacific Northwest Research Station. p 122–131. Available from: Pacific Northwest Research Station, 3625 93rd Avenue, Olympia, WA 98512.

RAPHAEL MG, JONES LLC. 1997. Characteristics of resting and denning sites of American marten in central Oregon and western Washington. In: Proulx G, Bryant HN, Woodard PM, editors. *Martes*: taxonomy, ecology, techniques, and management. Edmonton, AB: Provincial Museum of Alberta. p 146–165.

STRICKLAND MA, DOUGLAS GW, NOVAK M., HUNZIGER NP. 1982. Marten. In: Chapman JA, Feldhamer GA, editors. Wild mammals of North America: biology, management, economics. Baltimore, MD: John Hopkins University Press. p 599–612.

STURTEVANT BR, BISSONETTE JA. 1997. Stand structure and microtine abundance in Newfoundland: implications for marten. In: Proulx G, Bryant HN, Woodard PM, editors. *Martes*: taxonomy, ecology, techniques, and management. Edmonton, AB: Provincial Museum of Alberta. p 182–198.

*[USDA] US DEPARTMENT OF AGRICULTURE, FOREST SERVICE. 1990. Land and resource management plan. Baker City, OR: Wallowa-Whitman National Forest. 334 p. Available from: Wallowa-Whitman National Forest, P.O. Box 907, Backer City, OR 97814.

WECKWERTH RP, HAWLEY VD. 1962. Marten food habits and population fluctuations in Montana. Journal Wildlife Management 26:55–74.

WORTON BJ. 1989. Kernel methods for estimating the utilization distribution in home-range studies. Ecology 70:164–168.

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